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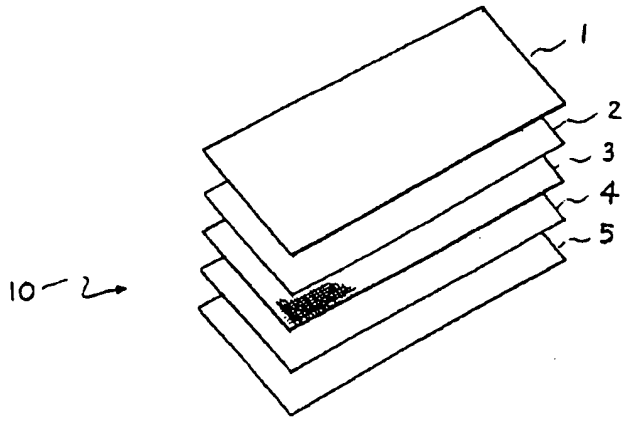
(54) Title: AN ODOR REMOVING ARTICLE AND METHOD FOR MAKING SAME



(57) Abstract: A structured article made of activated carbon-cloth adsorbent and at least one support bonded to said cloth to provide an article for the removal of odor from a confined space. The construction of the article is such that the article is resistant to mechanical abrasion and thereby allows for multiple regeneration and reuse of the multilayered article.

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AN ODOR REMOVING ARTICLE AND METHOD FOR MAKING SAME

FIELD OF INVENTION

This invention relates to a regenerable odor removing article for use in confined spaces and to a method of producing such articles and using same.

BACKGROUND OF THE INVENTION

It is well known that activated carbons have an ability to adsorb a wide range of chemical species due to their characteristically high surface areas that are a result of their large micropore volume. Activated carbon adsorbents in the form of loose granules or pellets in packed beds, for example, can be used to remove toxic or odorous materials components for years. Industrial-scale packed beds have volumes as large as several thousands of cubic feet. Smaller packed-bed devices have been used for household purposes, such as for the removal of taste and odor from tap water.

The smaller home devices are typically discarded after one use because it is not feasible to regenerate and reuse them. Therefore, in order to ensure their effectiveness over reasonable lengths of time, the volumes of adsorbent in such devices are typically large, for example, on the order of several hundred cubic centimeters. This size requirement is a disadvantage when such a device must be used in a confined space since they take up valuable space. Unfortunately, these devices are made up of carbon beds which must expose a maximum external area to be effective use. Often dust is generated by abrasion of such particulate which escapes from the containing means deposits on nearby surroundings. This further limits the appeal of such devices. Accordingly, it is an object of the present invention to provide a regenerable article comprising activated carbon adsorbents for removing odor and the like from confined spaces,

which article does not have the disadvantages of prior-art odor-removing adsorbent materials. It is a further object of the present invention to provide a method for removing odor from confined spaces using regenerable articles comprising activated carbon adsorbents. It is still another object of the present invention to provide regenerable activated carbon cloth articles for removing odor from confined spaces.

SUMMARY OF THE INVENTION

Generally, the present invention provides a structured article suitable for use in the removal of odor in a confined space which comprises at least one layer of activated carbon cloth having capacity to adsorb a wide range of chemical species that are responsible for the presence of odor in the confined space. At least one other layer is provided which is a porous support layer for the activated carbon cloth. In a preferred embodiment, the activated carbon cloth is encapsulated between porous support layers. Such layers are held strongly together by a lamination process using a bending agent or adhesive material between any two layers. Typically, this lamination process applies a heat source to the layers under an applied pressure, thereby melting the adhesive and providing the integrity and mechanical strength to the article. Generally, the porous support layer may be made of woven, non-woven, or knitted textile fabric. It is desirable the support layer be permeable to the atmosphere. As many as five or more layers of support material bonding media or the like can be used provided that the porosity of each layer of the multilayered unit is sufficient to allow the permeability of air there through.

Further, additional layers of activated carbon cloth may be provided between the first and second porous support layers for increased adsorption capacity, each additional layer of activated

carbon cloth is bonded or attached to another layer of the same by an interportioned "layer" of porous bonding or adhesive material. The activated carbon cloth may be preferably impregnated with any material that can enhance its adsorption capacity, or otherwise prolong the useful life of the odor removing article, for specific odor-generating materials of a specific application. For example, activated carbon cloth impregnated with a non-volatile acidic material is desirable where a basic material is responsible for the generation of the odor. Alternatively, each layer of multiple layers of activated carbon cloth can be impregnated with a different material that enhances the removal of different odor generating material to increase the effective removal of a wider spectrum of odor-generating materials.

Preferably, the bonding and adhesives used are selected such that the resultant laminated article is resistant to mechanical abrasion and to dissolution upon exposure to water or detergents. Further, the laminates should be resultant to disintegration at temperatures that are higher than ambient temperature of their use, yet sufficient to desorb substantially all the adsorbed odor generating materials. The laminate components must be sufficiently resistant to withstand accelerated regenerative drying temperatures. The increased mechanical strength of the odor-removing article of the present invention renders it reusable in multiple cycles of adsorption of odor followed by regeneration of the activated carbon cloth material. All the layers of the laminated article may have the same surface area. Alternatively, the surface area of the activated carbon cloth layers may be somewhat smaller than that of the porous support layers and the adhesive layers so that the activated cloth layers are completely enclosed or encapsulated within the article for further enhancement of the mechanical strength of the article.

The article of the present invention provides effective odor removal from confined spaces and more effective than typical prior art devices. Other advantages of the present invention will become apparent for a perusal of the following detailed description of the invention taken together with its accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic diagram of a five-layer odor-removing article of the present invention wherein one layer of activated carbon cloth is provided and all the layers have the same surface area.

Figure 2 is a schematic diagram of a seven-layer odor-removing article of the present invention wherein two layers of activated carbon cloth are provided and the surface area of the activated carbon cloth layers is smaller than that of the porous support layers and the adhesive layers.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is now described in details in conjunction with the attached drawings. Figure 1 illustrates a five-layer odor-removing structured activated carbon cloth article 10 of the present invention. A porous support layer 1 is provided. An adhesive layer 2 is disposed on one face of the support layer 1 . An activated carbon cloth layer 3 acting as the odor-removing agent is disposed on the free face of the adhesive layer 2 opposite to the support layer 1. Another adhesive layer 4 is disposed on the free face of the activated carbon cloth layer 3 opposite to the adhesive layer 2. Another porous support layer 5 is disposed on the free face

of the adhesive layer 4 opposite to the activated carbon cloth layer 3. The layers 1 through 5 are held together securely as a single unit by a lamination process wherein a heat source is applied to the unit under an applied pressure. The heat source provides a temperature sufficient to substantially melt the adhesive layers such that the all the layers are bonded together securely and uniformly under an externally supplied pressure. Typically, a pressure of from about 15 to about 150 psia is sufficient to produce a strong multilayered article of the present invention at the same time allowing a substantially rapid permeation of air there through. It may be desirable to use a higher pressure when additional layers of activated carbon cloth and intervening adhesive layers are included between the two support layers. Alternatively, adhesive materials that are curable at substantially ambient temperature may be used. For example, some epoxy resins that are cured at ambient temperature by a polymerization-initiating catalyst may be used as adhesives.

The porous support layers 1 and 5 may be made of woven, non-woven, or knitted fabric or sheet. Examples of materials suitable for use as support layers are natural or synthetic woven or knitted fibers; such as cotton, wool, polyester, rayon, nylon, polyethylene, polypropylene, polytetrafluoroethylene, polyamide, or other polymeric materials; and non-woven materials such as felt or foam that can provide strength and flexibility to the final multilayered article. The materials used for the support layers may be desirably treated to be water-repellent or fire resistant. In certain applications, it may be desirable to select two different materials for the two support layers.

Materials suitable to be used for the adhesive layers are thermoplastic polymers such as polyamide, polyester, and polyethylene that are in the form of a grid, a web, or a perforated

sheet. However, other materials may be used if they become cured, or are otherwise rendered insoluble in water or detergent solutions upon exposure to the heating during the lamination process or to the initiation of a polymerization of the adhesive material by a catalyst.

Activated carbon cloth of layer 3 suitable for used as the odor-removing agent may be made from natural or synthetic carbonaceous fiber precursor formed in a woven, non-woven, or knitted fabric. Rayon fiber produced by the viscose process is a particularly suitable feed stock for the production of activated carbon cloth. The fabric is then carbonized and activated thermally or chemically in an atmosphere comprising oxygen-containing gases in any well known process of manufacture of activated carbon. It is particularly desirable to use a feed stock comprising micron-sized fibers as they produce activated carbon fibers having rates of adsorption that are much higher than traditional activated carbon granules or particles due to the very short diffusion path of these activated carbon fibers. Microfibers made from coal tar, wood tar, or petroleum pitch also may be processed in manners well-known in the art of manufacturing of activated carbon to possess adsorption properties that are suitable for use as fiber precursors for activated carbon cloth.

The activated carbon cloth may be also desirably impregnated with any chemical that can enhance its removal capacity for a specific chemical species that is responsible for the presence of the odor in a specific application. Any traditional impregnation method is suitable; such as soaking or spraying with a solution containing the suitable chemical impregnant, followed by optional drying, and further optional heat treatment; or subliming the solid impregnant, depositing, and fixing onto the activated carbon cloth. For example, a nonvolatile acidic material may be impregnated into the activated carbon cloth to enhance its removal capacity for basic

materials, or a basic material impregnated to enhance removal of acid odor generators. Selected metals at appropriate loadings also may be impregnated into the activated carbon cloth. For example, copper at a loading from about 5 to about 20 percent by weight of the activated carbon cloth was found to enhance its removal capacity of hydrogen sulfide. Suitable activated carbon cloth materials are those having a density of up to about 500 g/m^2 of area, preferably up to about 300 g/m^2 of area, and an adsorption capacity for iodine of greater than about 600 mg/g, preferably greater than about 800 mg/g, as measured according to Test Method 4 of Calgon Carbon Corporation, Pittsburgh, Pennsylvania.

It is also preferable to eliminate the adhesive layers 2 and 4 and to provide the adhesive or bonding material directly on one the support layers to adhere to the activated carbon cloth layer. Additionally, the bonding support layer(s) directly to the activated carbon cloth. A number of synthetic fabrics can be heat and/or pressure fused directly to the activated carbon cloth. In such preferred embodiments, a distinct layer will not typically exist.

Figure 2 illustrates another embodiment of the present invention wherein two layers of activated carbon cloth are provided. Additional activated carbon cloth layers may be included to further increase the odor-removing capacity of the article. In this case, an increase in article strength is provided by including a layer of adhesive material between every two layers of activated carbon cloth. Two outside porous support layers 11 and 17 are provided with adhesive layers 12, 14, and 16 respectively, and activated carbon cloth layers 13 and 15. As is illustrated in Figure 2, the activated carbon cloth layers and adhesive "layers" having a smaller area than support layers and the outer adhesive areas to completely enclosed or encapsulated the activated carbon cloth within the article. Furthermore, adhesive layers 12 and 16 can be eliminated by

bonding or placing a bonding agent or adhesive material on support layers 11 or 17 agent or activated carbon cloth layers 13 and 15. Preferably, if an adhesive is used of adhesive material imprinted directly on a face of the support layer facing the adjacent activated carbon cloth layer.

The presence of the support layers and the resistance to mechanical abrasion of the article provided by the lamination process allow the article to be regenerated and substantially fully reused for odor removal repeatedly. The advantage of such multiple use cycles to the substantially full capacity of an odor-removing article is not possible or easily achievable by traditional adsorbents or absorbents such as granular activated carbon, zeolite, silica gel, or baking soda.

Odor in a confined space is reduced or eliminated by exposing the structured activated carbon cloth article of the present invention to the interior of a defined space. For small spaces, the size of the structured article can be relatively small. Chemical species responsible for the generation of odor permeate through the structured article and are adsorbed therein. Structured articles of the present invention are very effective in removing odor from shoe or travel bags, closets, closed containers for soiled clothes, interior of refrigerators, interior of motor vehicles, confined living spaces for pets and the like. Structured articles of the present invention can be made small, e.g., 10 cm x wum or quite large depending put the intended use.

When the odor removal capacity of the structured article is exhausted, it can be regenerated for reuse by washing with water or detergent and drying. Regeneration of the article to remove the adsorbed odor-generating species also may be effected by heating to a temperature higher than ambient temperature but lower than a temperature that would disintegrate the bond.

Other odor-generating species also may be desorbed by simply exposing the article in a large quantity of fresh air.

Although the two embodiments of the present invention shown in Figures 1 and 2 have been depicted in rectangular shapes, other shapes may be used without departing from the scope of the present invention. Moreover, the number of layers can be from two to multiple layers and can be laminated or compressed into dimensional forms that fit into confined spaces more effectively or enhance diffusion of odors for adsorption.

The following examples illustrate the advantages achieved by the present invention.

EXAMPLE 1

A structured article of the present invention made with FM1/250 activated carbon cloth (Calgon Carbon Corporation, Pittsburgh, Pennsylvania) was tested for repeated use to remove odor emanated respectively from a curry sauce, a garlic sauce, and a cheese into a confined space. These foodstuffs represented the types of odors that are encountered inside a refrigerator. The structured article had a dimension of 4 in.x 4 in. and comprised one layer of FMl/250, two porous support layers made of Permess 010073™ knitted nylon fabric having a fusible polyamide adhesive disposed on one face of the porous nylon fabric. All the layers were held together by a lamination process at 140°C and about 36 psia.

The garlic sauce contained sunflower oil, garlic, and a spirit vinegar. The curry sauce contained tomatoes, a spirit vinegar, onions, sunflower oil, spices, malt vinegar, mango chutney, and tamarinds. Into a container having a volume of 816 cm^3 was placed a quantity of 10g of each foodstuffs. The multilayered article of the invention described above was securely taped

inside the container over a small opening cut into one side of the container, and the container was sealed and placed in a refrigerator. At 1 5-minute intervals, the containers were removed from the refrigerator and an operator determined whether any odor was detectable immediately outside the container at the opening. The time for odor breakthrough was defined as that at which odor from each foodstuff was detected. The multilayered odor-removing article was then regenerated for further use by washing in a Hotpoint 951 30™ washing machine at 60°C using 20g of Persil™ non-biological washing powder. The washed article was dried in a Multivent 261™ tumble dryer on a 60-minute cycle for non-delicate items. The temperature inside the dryer was 60°C. The cycle of odor removal followed by a regeneration by washing and drying was repeated five times. The odor breakthrough times for each foodstuff are shown in Table 1.

Table 1

Time taken for odor to be detected

Cycle	Curry Sauce	Garlic Sauce	Cheese
1	19 hours 45 minutes	2 hours 45 minutes	No breakthrough
2	19 hours 15 minutes	2 hours 30 minutes	No breakthrough
3	19 hours 15 minutes	2 hours 30 minutes	No breakthrough
4	19 hours 30 minutes	2 hours 0 minute	No breakthrough
5	19 hours 0 minute	1 hour 45 minutes	No breakthrough

The tests demonstrated that a structured odor-removing article of the present invention effectively removed typical odors that are encountered in the confined interior of a refrigerator

and this use could be repeated may times with intervening regeneration without substantially affecting its odor-removing effectiveness.

EXAMPLE 2

In this example, the effectiveness of a simulated structured article of the present invention having two layers of FM1/250 activated carbon cloth was compared to that of baking soda in the removal of various odors. Two circular layers of FM1/250 activated carbon cloth having a 3-in diameter and a total weight of about 2.5g were placed in a shallow cartridge of a type used for personal respirator. A quantity of 25g of Arm&Hammer™ baking soda (100% sodium bicarbonate) was placed in another identical cartridge. Both cartridges were sealed and tested for their capacities to remove odor from oil of wintergreen (methyl salicylate), garlic, shrimp, and naphthalene. Each odorous material was placed in a test tube, and a stream of air at 1 liter/minute was passed over the odorous material to carry the evolved odor to the cartridge containing the activated carbon cloth. Due to a much larger pressure drop through the baking soda cartridge, the air flow rate was set at only 0.45 liter/minute. Odor breakthrough was checked periodically. Breakthrough time was recorded before a moderate-to-strong odor was detected. The deodorizing capacity of each adsorbent was defined as the volume of air treated per gram of adsorbent. The results of this test are shown in Table 2.

Table 2

Odor Type	Oil of Wintergreen		Garlic		Shrimp		Naphthalene	
Adsorbent	Baking Soda	FM1/250	Baking Soda	FM1/250	Baking Soda	FM1/250	Baking Soda	FM1/250
Estimated Contact Time (sec.)	0.7	0.3	0.7	0.3	0.7	0.3	0.7	0.3
Odor Breakthrough Time (min.)	20-30	180-210	10-20	>360	20-30	>270	30-45	>620
Deodorizing Capacity (l/g)	0.4-0.5	145-170	0.2-0.4	>280	0.4-0.5	>215	0.5-0.7	>490

Thus, it was demonstrated that a stimulated multilayered article of the present invention comprising two layers of activated carbon cloth was much more effective than an even greater quality of baking soda that has been used typically for odor removal. The deodorizing capacity of activated carbon cloth was at least 150 times that of baking soda.

While presently preferred embodiments of the present invention have been described and shown in detail, it is understood that the present invention may be embodied within the scope of the appended claims.

WHAT IS CLAIMED:

1. A method for removing odor from a confined space comprising:

(a) placing a structured article comprising:

a porous support layer; and

an adsorbed layer comprising an odor-removing adsorbent material, said adsorbed layer being bonded to said support layer, into a confined space; and

(b) exposing said article to odor in an interior of said confined space to said remove odor therefrom.

2. A structured article for removing odor from a confined space according to Claim 1 wherein said support and adsorbent layers are bonded together by a compression at a temperature above ambient.

3. A structured article as set forth in Claim 1 wherein said support and adsorbent layers are bonded with an adhesive.

4. A structured article as set forth in Claim 2 wherein said adhesive comprises a layer between adjacent layers.

5. A structured article for removing odor from a confined space according to Claim 2 wherein said temperature is in the range of from about 60°C to about 150°C.

6. A structured article for removing odor from a confined space according to Claim 2 wherein said applied pressure is in the range of from about 10 psig to about 150 psig.

7. A structured article for removing odor from a confined space according to Claim 1 wherein said article further comprises at least one additional support layer, said additional support layer being bonded to said adsorbent layer.

8. A structured article as set forth in Claim 1 wherein said support layer comprises a washable textile fabric.

9. A structured article as set forth in Claim 1 wherein said support layer is a fabric selected from the group consisting of cotton, wool, polyester, rayon, nylon, polyethylene, polypropylene, polytetrafluoroethylene, and polyamide.

10. A structured article as set forth in Claim 1 wherein said activated carbon cloth has a surface density of less than about 500g/m^2.

11. A method for removing odor from a confined space according to Claim 10 wherein said odor-removing adsorbent material of said adsorbent layer comprises activated carbon cloth.

12. A method for removing odor from a confined space according to Claim 10 wherein said porous support layer comprises washable textile fabric.

13. A method for removing odor from a confined space according to Claim 1 wherein said bending includes an adhesive material.

14. A method for removing odor from a confined space as set forth in Claim 13 wherein said adhesive comprises at least one thermoplastic polymer.

15. A method for removing odor from a confined space according to Claim 11 wherein said activated carbon cloth has an iodine adsorption capacity of at least 600 mg/g.

16. A method for removing odor from a confined space according to Claim 11 wherein said activated carbon cloth has a surface density less than about 500 g/m^2.

17. A method for removing odor from a confined space according to Claim 16 wherein said activated carbon cloth has a surface density of about 250 g/m^2.

18. A method for removing odor from a confined space according to Claim 1 wherein said multilayered article further comprises at least one additional layer of odor-removing activated carbon cloth.

19. A method for removing odor from a confined space according to Claim 8 wherein said multilayered article further comprises at least one layer of adhesive material between two layers of odor-removing activated carbon cloth.

20. A method for removing odor from a confined space according to Claim 12 wherein said washable textile fabric is selected from the group consisting of woven, non-woven, and knitted fabric.

21. A method for removing odor from a confined space according to Claim 20 wherein said washable fabric comprises fibers selected from the group consisting of cotton, wool, polyester, rayon, nylon, polyethylene, polypropylene, polytetrafluoroethylene, and polyamide.

22. A method for removing odor from a confined space according to Claim 1 further comprising the steps of: (c) regenerating said multilayered article that has been exposed to odor to provide a regenerated article; and (d) re-exposing said regenerated article to said confined space to remove odor therefrom.

23. A method for removing odor from a confined space according to Claim 12 further comprising repeating a sequence of said steps (c) and (d) at least one time.

24. A method for removing odor from a confined space according to Claim 12 wherein said step of regenerating comprises washing and drying.

25. A method for removing odor from a confined space according to Claim 1 wherein said multilayered article further comprises at least one additional porous support layer, said additional support layer being bonded to said second layer by a second adhesive material disposed between said second layer and said additional support layer.

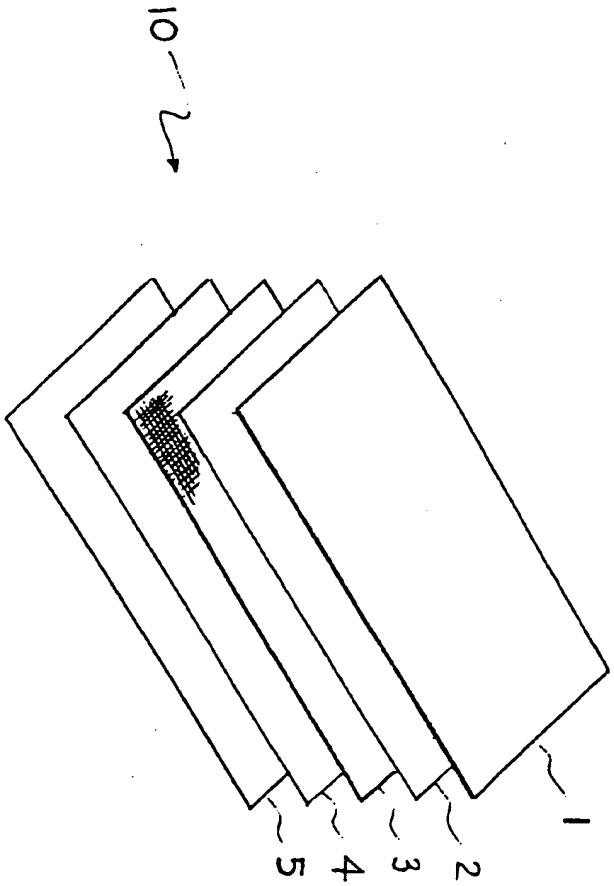

FIGURE 1

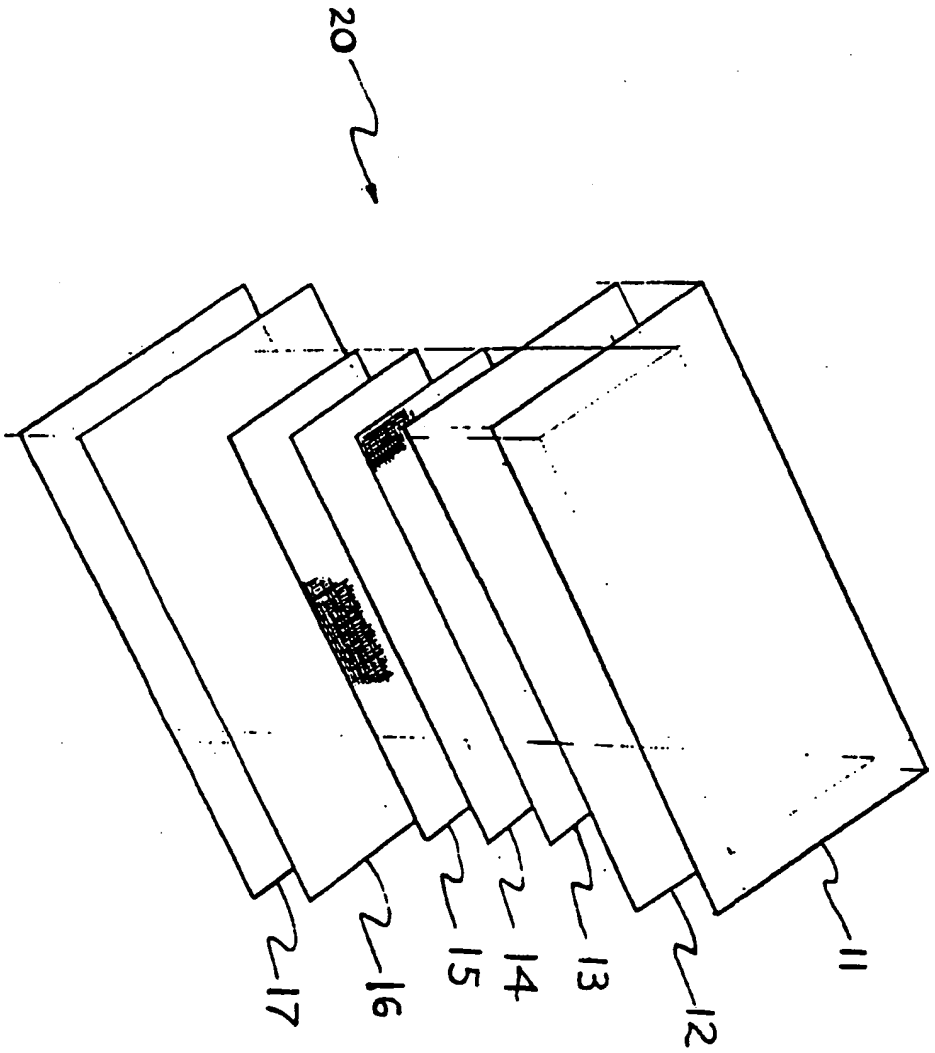

FIGURE 2

INTERNATIONAL SEARCH REPORT

In ational Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61L9/014 A61L9/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61L B01D F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	DATABASE WPI Section Ch, Week 199936 Derwent Publications Ltd., London, GB; Class D22, AN 1999-423036 XP002155202 & JP 11 169641 A (NAKAWARA S), 29 June 1999 (1999-06-29) abstract ---	1,7-10, 12,22-24
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[X] Further documents are listed in the continuation of box C. [X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2000	21/12/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

In ational Application No
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